APPLICATION FOR
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TITLE: TRANSFER CHAMBER FOR VACUUM PROCESSING SYSTEM

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TRANSFER CHAMBER FOR VACUUM PROCESSING SYSTEM

The present application claims priority from U.S.
5   Provisional Patent Application Serial No. 60/390,629, filed
June 21, 2002, and titled "Transfer Chamber For Vacuum
Processing System" and from U.S. Provisional Patent Application
Serial No. 60/392,578, filed June 28, 2002, and titled
"Transfer Chamber For Vacuum Processing System", both of which
10   are hereby incorporated by reference herein in their entirety.

FIELD OF THE INVENTION

This invention is generally concerned with processing
systems used for processing substrates, and is more
15   particularly concerned with a transfer chamber for use in such
a system.

BACKGROUND OF THE INVENTION

Conventional techniques for manufacturing flat panel
20   displays or semiconductor devices entail applying a sequence of
processes to a substrate such as a glass plate or a silicon
wafer. The processes to be applied may include thermal
processing, physical vapor deposition (PVD), chemical vapor
deposition (CVD), etching, etc. Typically, each process in the
25   sequence of processes is performed in a respective processing
chamber. Accordingly, the substrates upon which the processes
are performed must be transferred from one processing chamber
to another.

It is also conventional to incorporate a number of
30   different processing chambers in a single processing tool,
wherein the processing chambers are coupled around the
periphery of a central transfer chamber. FIG. 1 is a somewhat
schematic vertical cross-sectional view of a conventional

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processing tool 11. The processing tool 11 includes a
centrally-positioned transfer chamber 13. A load lock chamber
15 and a processing chamber 17 are shown coupled to respective
sides of the transfer chamber 13. One or more additional

5   process chambers and/or load lock chambers, which are not
shown, may also be coupled to respective sides of the transfer
chamber 13. The load lock chamber 15 is provided to
accommodate introduction of substrates into the processing tool
11 from outside of the processing tool 11.

10   The transfer chamber 13 includes a main body 19
having side walls 21 (of which only two are visible in FIG. 1).
Each side wall 21 may be adapted to have a load lock or
processing chamber coupled thereto. The transfer chamber 13
also includes a top 23 supported on the main body 19. A lid 25

15   is provided to sealingly close the top 23 of the transfer
chamber 13.

            A lower end of the transfer chamber 13 is closed by a
substantially annular bottom 27. The bottom 27 of the transfer
chamber 13 has a central aperture 29 which accommodates

20   installation of a substrate handling robot 31 in the transfer
chamber 13. The substrate handling robot 31 is adapted to
transfer substrates among the processing chambers 17 and the
load lock chamber or chambers 15 coupled to transfer chamber
13.

25   To minimize the possibility of contamination of
substrates processed in the processing tool 11, it is customary
to maintain a vacuum in the interior of the transfer chamber
13. Hence, the processing tool 11 may be referred to as a
vacuum processing system. A pumping system, which is not

30   shown, may be coupled to the transfer chamber 13 to pump the
transfer chamber 13 down to a suitable degree of vacuum.

            Also illustrated in FIG. 1 is an actuator 33 which
selectively opens and closes a slit valve 35 associated with

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the processing chamber 17. When the slit valve 35 is in an
open position (not shown), a substrate may be introduced into
or removed from the processing chamber 17. When the slit valve
35 is in the closed position illustrated in FIG. 1, the

5   processing chamber 17 is isolated from the transfer chamber 13
so that a fabrication process may be performed on a substrate
within the processing chamber 17.

Processing tools, and in particular the transfer
chamber portions thereof, are manufactured in a variety of

10 sizes. In some cases it is necessary or desirable that the
transfer chamber 13 be quite large. For example, in a
processing tool used for fabricating flat panel displays, the
glass plate substrates that are processed currently range from
about 0.5 to 1.5 meters per side, and may reach 2-3 meters per

15 side in the near future. Accordingly, a very large transfer
chamber is required for such applications. In addition, it may
be desirable to increase the number of processing chambers
and/or load locks included in the processing tool, which also
may require that the transfer chamber be made large. However,

20 increasing the size of a transfer chamber increases vacuum
induced stresses in components thereof such as the bottom of
the transfer chamber. To accommodate such stresses, the
thickness of the bottom of a transfer chamber may be increased
to provide increased strength. However, increased thickness of

25 the transfer chamber bottom results in greater weight,
increased difficulty in manufacture, and higher cost.

SUMMARY OF THE INVENTION
According to a first aspect of the invention, a

30 transfer chamber is provided, including a main body having side
walls adapted to couple to at least one processing chamber and
at least one load lock chamber. The main body is also adapted
to house at least a portion of a robot adapted to transport a

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substrate between the at least one processing chamber and the at least one load lock chamber. The inventive transfer chamber also includes a lid adapted to couple to and to seal a top portion of the main body of the transfer chamber. The

5   inventive transfer chamber further includes a domed bottom adapted to couple to and to seal a bottom portion of the main body of the transfer chamber.

According to a second aspect of the invention, a vacuum processing system includes a transfer chamber as

10   described above in connection with the first aspect of the invention. The inventive vacuum processing system also includes at least one processing chamber coupled to the main body of the transfer chamber and at least one load lock chamber coupled to the main body of the transfer chamber. The

15   inventive vacuum processing system further includes a robot that at least partially extends through the domed bottom into the transfer chamber. The robot is adapted to transport a substrate between the at least one processing chamber and the at least one load lock chamber via the transfer chamber.

20   According to a third aspect of the invention, a method of forming a domed bottom for a transfer chamber is provided. The transfer chamber is adapted to couple at least one load lock chamber to at least one processing chamber. The method includes selecting a material and forming a domed bottom

25   from the material. The domed bottom has an outer diameter sized to fit against and configured to form a seal with a bottom portion of a main body of a transfer chamber. The domed bottom also has an aperture having a diameter sized to accommodate at least a portion of a robot. The robot is

30   adapted to transfer substrates between at least one load lock chamber and at least one processing chamber coupled to the transfer chamber.

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Because the transfer chamber bottom provided in accordance with the invention has a domed configuration, the inventive transfer chamber bottom exhibits greater strength than would a transfer chamber bottom of equal thickness having

5   a flat configuration. Accordingly, the inventive transfer chamber bottom may be made thinner than conventional flat bottoms of transfer chambers of comparable size, thereby providing savings in cost and weight.

Further features and advantages of the present

10   invention will become more fully apparent from the following detailed description of exemplary embodiments, the appended claims and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

15   FIG. 1 is a vertical cross-sectional view of a conventional vacuum processing system;

FIG. 2 is a vertical cross-sectional view of a vacuum processing system provided in accordance with a first embodiment of the invention;

20   FIG. 3 is an exploded view of a transfer chamber that is part of the inventive vacuum processing system of FIG. 2;

FIG. 4 is a simplified schematic side view of an exemplary embodiment of the transfer chamber of FIGS. 2 and 3; and

25   FIG. 5 is a schematic vertical cross-sectional view of a vacuum processing system provided in accordance with another embodiment of the invention.

DETAILED DESCRIPTION

30   In accordance with the invention, the bottom of a transfer chamber is provided in a domed configuration, thereby achieving greater strength for a given thickness of the bottom and reducing the interior volume of the transfer chamber. As a

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result, the bottom of the transfer chamber may be made thinner than conventional transfer chamber bottoms, so that a savings in cost and weight is realized. The reduced interior volume of the transfer chamber also may decrease pump down times, thereby

5   increasing throughput.

An embodiment of the invention will now be described with reference to FIGS. 2 and 3.

FIG. 2 is a view similar to FIG. 1 of a processing tool (vacuum processing system) 201 provided in accordance with

10 an embodiment of the present invention. The inventive processing tool 201 includes a novel transfer chamber 203. A conventional load lock chamber 15 (which may be, for example, a double dual slot load lock (DDSL) or other conventional load lock) and a conventional processing chamber 17 are shown

15 coupled to the inventive transfer chamber 203. It will be understood that one or more additional process chambers and/or load lock chambers may also be coupled to the transfer chamber 203, although not shown in the drawings. A substrate handling robot 205 is disposed within the transfer chamber 203. As with

20 the conventional system of FIG. 1, a pumping system (not shown) may be coupled to the inventive transfer chamber 203 to pump down the transfer chamber 203 to a suitable degree of vacuum. For convenience, the inventive transfer chamber 203 will be described with reference to both FIG. 2 and FIG. 3 (which is an

25 exploded view of the inventive transfer chamber 203).

With reference to FIGS. 2 and 3, the transfer chamber 203 includes a main body 207, which may be, for example, machined from a single piece of material such as aluminum. Other materials may be employed. As described further below,

30 in at least one embodiment of the invention the height of the main body 207 (H_{mB}) is minimized so as to reduce the overall volume and weight of the transfer chamber 207. The main body 207 may have a cylindrical interior wall 209 and an exterior

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wall 211 having flat regions 213 which form side walls 215
(FIG. 2) that are adapted to couple to processing chambers or
load lock chambers.   In at least one embodiment, each side wall
215 (FIG. 2) may, for example, have a thickness of about two

5   inches at its thinnest point (e.g., the center of each flat
region 213).   Other side wall thicknesses may be employed.
Each side wall 215 may include one or more respective slits 217
(FIG. 3) through which a substrate (not shown) may be
transferred from the transfer chamber 203 to a processing

10   chamber 17, or vice versa, by the substrate handling robot 205.
A slit valve (not shown in FIGS. 2 and 3) may be associated
with each slit 217 to selectively open and close each slit 217.
In the embodiment of FIGS. 2 and 3, the transfer chamber 203
includes two slits 217a, 217b for allowing substrates to be

15   loaded into and out of the load lock chamber 15 at two
different heights.   The slits 217a, 217b may be sealed, for
example, via conventional gate valves 219a, 219b (FIG. 2).

        Although not shown in FIGS. 2 or 3, the transfer
chamber 203 may employ slit valve actuators internal to the

20   transfer chamber 203, such as the slit valve actuator 33 of
FIG. 1, to seal or open the slits 217 (e.g., a conventional 45
degree-type slit valve).   Alternatively, in at least one
embodiment, conventional gate valves (e.g., external gate valve
221 (FIG. 2) that moves vertically) may be positioned outside

25   the transfer chamber 203 to seal and open the slits 217. Such
a configuration may simplify the design of the domed bottom
(described below) of the transfer chamber 203.

        Referring again to FIG. 3, the inventive transfer
chamber 203 may also include a top member 223 which is

30   annularly shaped, and is adapted to be sealingly joined to an
upper portion of the main body 207 via a first O-ring 225.   The
inventive transfer chamber 203 may also include a lid 227 which
is provided to sealingly close an aperture 229 of the top

member 223 via a second O-ring 231. Other sealing mechanisms
may be employed as may other configurations for sealing the top
of the transfer chamber 203.

       In accordance with the invention, the transfer

5   chamber 203 also includes a bottom member 233 which has a domed
configuration, as best seen in FIG. 2. As will be observed
from FIG. 2, the bottom member 233 has a concave configuration
such that a vertical distance between the lid 227 of the
transfer chamber 203 and a central portion of the bottom member

10   233 is greater than a vertical distance between the lid 227 and
an outer edge of the bottom member 233. In one embodiment of
the invention, the bottom member 233 may be machined from a
single piece of material such as stainless steel. Other
materials and/or configurations may be used. Techniques that

15   may be employed to manufacture the bottom member 233 are
disclosed, for example, in co-pending U.S. patent application
serial no. 09/523,366, filed March 10, 2000 and entitled
"Vacuum Processing System for Producing Components" (Attorney
Docket No. 2801), which is incorporated herein by reference in

20   its entirety. Such techniques may include, for example,
spinning, rolling and/or the like.

       In one embodiment, the bottom member 233 may have a
thickness of about 0.5 to 0.625 inches (e.g., in the domed
region), as compared to a thickness of three inches for

25   conventional bottom members having a flat configuration and of
comparable size (e.g., with an outer diameter of about 2.6
meters). Other thicknesses may be employed.

       Referring again to FIG. 3, the bottom member 233 is
adapted to couple to and seal a bottom portion of the main body

30   207 via an outer edge 235 of the bottom member 233 and a third
O-ring 237. The bottom member 233 has a generally circular
central aperture 239. The outer edge 235 and central aperture
239 may be thicker than the remainder of the bottom member 233

(e.g., about two inches square in the above described
embodiment) and may be separately formed and attached to the
domed region (e.g., via welding). Various openings and/or
surface features 241 may be provided to accommodate sensors,
5   vacuum ports, gas ports, etc. An annular plug member 243 is
provided to seal the central aperture 239 of the bottom member
233 via a fourth O-ring 245. The plug member 243 has a central
aperture 247 sized to sealingly accommodate a portion of the
substrate handling robot 205 (FIG. 2) which extends through the
10   central aperture 247 of the plug member 243 and through the
central aperture 239 of the bottom member 233. A fifth O-ring
249 (FIG. 3) seals the central aperture 247 of the plug member
243 around the robot 205. Other sealing mechanisms may be
employed in place of or in addition to the O-rings 237, 245 and
15   249.

The present invention provides for a transfer chamber
in which the bottom has a domed configuration. Consequently,
for a given size of transfer chamber, the domed bottom can be
formed of thinner material than a conventional flat bottom. As
20   a result, the cost and weight of the transfer chamber bottom
can be reduced. This may be particularly significant in the
case of very large transfer chambers of the type employed with
processing tools which process glass plates for fabrication of
flat panel displays. Such a design may consume unused space
25   underneath a transfer chamber and does not interfere with
overhead height limitations (e.g., due to overhead factory
transport systems, ceiling heights, etc.).

As the flat panel industry continues to mature, the
size of the glass plates transferred within a transfer chamber
30   (such as the transfer chamber 203) continues to grow. Current
glass plate sizes are in the range of about 0.5 to 1.5 meters
per side. However, larger glass substrates are being developed
(e.g., about 2-3 meters per side). Increasing glass plate size

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requires transfer chambers of increasing diameter (and larger
load lock and process chambers for processing such larger
substrates). In the near future, the flat regions of a
transfer chamber (e.g., flat regions 213 in FIG. 3) may reach
5   dimensions of greater than about 2-4 meters to accommodate
similarly sized glass substrates. As transfer, load lock and
process chamber sizes increase, numerous factors should be
considered during transfer chamber design, such as robot size,
volume of the transfer chamber, space available underneath the
10   transfer chamber, vacuum forces generated within the transfer
chamber, weight of the transfer chamber, cost of the transfer
chamber and the like.

FIG. 4 is a simplified schematic side view of an
exemplary embodiment of the transfer chamber 203 of FIGS. 2 and
15   3. In FIG. 4, the transfer chamber 203 is coupled to at least
one load lock chamber 401 and at least one process chamber 403,
and includes the main body 207 as previously described. For
clarity, support structure for the transfer chamber 203, and
load lock and process chambers 401, 403, is not shown in FIG.
20   4.

One parameter relevant to the design of the transfer
chamber 203 is the space available underneath the transfer
chamber 203 to accommodate the domed bottom 233. With
reference to FIG. 4, the transfer chamber 203 has a minimum
25   transfer height H_{TR} which represents the minimum height at
which a substrate may be transferred within the transfer
chamber 203. The minimum transfer height H_{TR} may be an
industry standard, a requirement of the fabrication facility
employing the transfer chamber 203, or the like. In the
30   example of FIG. 4, the minimum transfer height H_{TR} is defined
relative to a floor 405 of a facility (not shown) in which the
transfer chamber 203 is located. The floor 405 may be, for
example, a floor of a clean room, a raised floor or any other

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lower limit on the space/area/height located below the transfer chamber 203.

The minimum transfer height H_{TR} sets the height (H_F) that the transfer chamber 203 is positioned above the floor

5   405. The volume below the transfer chamber 203 that may be employed to accommodate the domed bottom 233 is approximately the volume of a cylinder having a diameter equal to the inner diameter of the main body 207 of the transfer chamber 203 (D_{MB}) and a height equal to the height of the transfer chamber 203

10   above the floor 405 (H_F).

As shown in FIG. 4, the domed bottom 233 of the transfer chamber 203 includes a cylindrical region 233a having a height H_{D1} and a domed region 233b having a height H_{D2}. Accordingly, the volume of the domed bottom 233 is

15   approximately equal to the volume of the cylindrical region 233a plus the volume of the domed region 233b.

It is often preferable that the transfer chamber 203 have as small a volume as possible (e.g., to reduce pump down times thereby increasing throughput). Because a domed

20   configuration defines a smaller volume than a cylindrical configuration (within the same predefined spatial region), from a volume consideration, it may be desirable to maximize the portion of the transfer chamber 203 that is domed (e.g., making the domed region 233b of the domed bottom 233 larger while

25   reducing both the height H_{D1} of the cylindrical region 233a of the domed bottom 233 and the height H_{MB} of the main body 207). However, other factors influence the selection of the height H_{MB} of the main body 207 and the height H_{D1} of the cylindrical region 233a of the domed bottom 233. For example, the height

30   H_{MB} of the main body 207 of the transfer chamber 203 should be sufficient to accommodate any load lock chamber and/or process chamber coupled to the main body 207. In at least one embodiment of the invention, the height H_{MB} of the main body

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207 may be set, for example, based on the minimum height
required to accommodate the slit openings 217a, 217b that
interface with the load lock chamber 401.

With regard to the height H_{D1} of the cylindrical
5   region 233a of the domed bottom 233, the height H_{D1} should be
sufficient to accommodate the height of the substrate transfer
robot 205 (FIG. 2). As shown in FIG. 2, the substrate transfer
robot 205 includes a first arm 205a and a second arm 205b.
When the substrate transfer robot 205 is positioned to transfer
10   a substrate at a height near the minimum transfer height H_{TR},
such as through the opening 217b of the main body 207 of the
transfer chamber 203, the height H_{D1} of the cylindrical region
233a of the domed bottom 233 should be large enough to prevent
the second arm 205b of the robot 205 from extending into the
15   domed region 233b of the domed bottom 233 (whether the robot
205 is in a retracted position as shown in FIG. 2 or in an
extended position such as is shown by the robot 31 of FIG. 1).
If the height H_{D1} of the cylindrical region 233a of the domed
bottom 233 is not large enough to prevent the second arm 205b
20   from extending into the domed region 233b of the domed bottom
233, the domed region 233b may contact and interfere with
operation of the second arm 205b. As glass substrate size and
transfer chamber size increase, stiffness (and thus thickness)
of each robot arm 205a, 205b typically increases. A
25   corresponding increase in the height H_{D1} of the cylindrical
region 233b of the domed bottom 233 may be employed to
compensate for increased robot arm size.

Another factor that may affect the design of the
transfer chamber 203 is the strength required for the domed
30   bottom 233. As transfer chamber size increases, so does the
force exerted on the domed bottom 233 when the transfer chamber
203 is evacuated. Vacuum forces are most pronounced at the
outer edge 235 of the domed bottom 233; and the domed bottom

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233 should be sufficiently strong to resist vacuum induced
deflections that may affect the ability of the domed bottom 233
to seal relative to the main body 207 of the transfer chamber
203 and/or the robot 205 (FIG. 2).

5   From a strength standpoint, a spherical configuration
for the domed bottom 233 is preferred (as illustrated by domed
bottom 233' in FIG. 4). Such a configuration may be achieved
by employing a radius of curvature ($R_{D1'}$) of one half of the
main body 207's diameter (D_{MB}). However, as shown in FIG. 4, a
10   spherical configuration for the domed bottom 233 requires more
space underneath the transfer chamber 203 (e.g., and may
interfere with the floor 405 or another space limitation) and
results in a transfer chamber having a large volume. To reduce
the space/volume requirements of the domed bottom 233, a larger
15   radius of curvature (R_{D1}) may be employed for a first portion
407 of the domed region 233a of the domed bottom 233. In at
least one embodiment, the radius of curvature R_{D1} of the first
portion 407 of the domed bottom 233 is greater than one half of
the diameter D_{MB} of the main body 207 of the transfer chamber
20   203. In one particular embodiment, the radius of curvature R_{D1}
is about 1.5 times the diameter D_{MB} of the main body 207 of the
transfer chamber 203. Other values may be employed. Selection
of the radius of curvature R_{D1} may depend on many factors such
as the space available under the transfer chamber 203, the
25   strength of the material employed for the domed bottom 233,
etc.

          When the radius of curvature R_{D1} of the first portion
407 of the domed bottom 233 is greater than one half of the
diameter D_{MB} of the main body 207 of the transfer chamber 203,
30   the domed bottom 233 may be provided with a second radiused
portion 409 having a radius of curvature R_{D2}. This additional
radius of curvature compensates for the mismatch between the
radius of curvature R_{D1} of the first portion 407 of the domed

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bottom 233 and the radius of the main body 207 (one half of D_{MB}). In at least one embodiment of the invention, the radius of curvature R_{D2} of the second portion 409 is approximately 5-20 times the thickness of the domed bottom 233 (at its thinnest point).

Based on the foregoing and in accordance with the present invention, the transfer chamber 203 and/or the domed bottom 233 may be designed as follows:

(1)   determine the space underneath the transfer chamber 203 available for the domed bottom 233 (e.g., based on minimum transfer height H_{TR} and/or the height H_F of the transfer chamber 203 above any interfering structure such as the floor 405);

(2)   determine the radius of curvature R_{D1} for the first portion 407 of the domed bottom 233 (e.g., based on the height H_F of the transfer chamber 203 above the floor 405, minimum transfer height H_{TR}, desired overall size of the transfer chamber 203, dimensions of the robot 205 such as width and height, the amount of deflection of the domed bottom 233 that is tolerable, the vacuum levels to be employed within the transfer chamber 203, etc.);

(3)   determine the thickness of the domed bottom 233 (e.g., based on the radius of curvature R_{D1} for the first portion 407 of the domed bottom 233, material strength, the amount of deflection of the domed bottom 233 that is tolerable, the vacuum levels to be employed within the transfer chamber 203, etc.);

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(4)   determine the height H_{MB} of the main body 207 of the
      transfer chamber 203 (e.g., based on the size of the
      load lock and/or process chambers to be coupled to
      the main body 207, the height required to accommodate
5   the slit openings used to interface the load lock
      and/or process chambers to be coupled to the main
      body 207, etc.);

(5)   determine the height H_{D1} of the cylindrical region
10   233a of the domed bottom 233 (e.g., based on the size
      of the robot 205 such as the thickness of the second
      arm 205b, the minimum transfer height H_{TR} of the
      transfer chamber 203, the distance between the second
      arm 205b and an end effector 205c of the robot 205
15   (FIG. 2), etc.); and/or

(6)   determine the radius of curvature R_{D2} for the second
      portion 409 of the domed bottom 233 (e.g., based on
      the radius of curvature R_{D1} of the first portion 407
20   of the domed bottom 233, the height H_{D1} of the
      cylindrical region 233a of the domed bottom 233,
      etc.)

Any of the above factors may be employed alone or in
25 combination, and in any order for designing one or more of the
transfer chamber 203 and/or the domed bottom 233.   Other
factors may be considered during design of the transfer chamber
203 and/or the domed bottom 233, such as the diameter (D_{DB}) of
the aperture required to accommodate the robot 205, the affect
30 of such an aperture on domed bottom strength, or the like.

In one exemplary embodiment of the invention, the
transfer chamber 203 is configured as follows:

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(1)   diameter D_{MB} of the main body 207 equals about 2.6 meters;

5   (2)   height H_{MB} of the main body 207 equals about 0.8 meters;

(3)   height H_{D1} of the cylindrical region 233a of the domed bottom 233 equals about 6 inches;

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(4)   height H_{D2} of the domed region 233b of the domed bottom 233 equals about 12 inches;

(5)   thickness of the cylindrical and domed regions 233a, 15   233b of the domed bottom 233 equals about 0.5-0.625 inches;

(6)   radius of curvature R_{D1} of the radiused portion 407 of the domed bottom 233 equals about 1.5 times the 20   diameter of the main body 207;

(7)   radius of curvature R_{D2} of the radiused portion 409 of the domed bottom 233 equals about 5-20 times the thickness of the domed region 233b; and

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(8)   thickness of the main body 207 equals about 2 inches (at its thinnest point).

Other transfer chamber configurations may be employed.

30   Referring again to FIG. 2, exemplary support structure 241 for the transfer chamber 203 and/or the robot 205 is illustrated. Such support structure may include, for example, one or more suitably sized pedestal legs 243, cross

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members 245 and/or braces 247.   In general, any mechanism for
supporting the transfer chamber 203 or the robot 205 may be
employed. The load lock chamber 15 may be supported, for
example, via a clean room wall 249 and/or the transfer chamber
5   205; and the processing chamber 17 may be supported, for
example, by one or more pedestals 251 and/or cross members 253.
Other supporting configurations may be employed.

In at least one embodiment of the invention, the
support structure 241 is adapted to support the main body 207
10 of the transfer chamber 203 and the robot 205 without directly
supporting the domed bottom 233. For example, pedestals 243
may interface with flat regions 213 (FIG. 3) of the main body
207 without contacting the domed bottom 233; and cross members
245 and braces 247 may support a main trunk 255 of the robot
15 205 without contacting the domed bottom 233 (as shown). The
domed bottom 233 may be supported by the main body 207 (e.g.,
by hanging therefrom, such as via bolts or other fastening
mechanisms not shown).

In the above described embodiment, the domed bottom
20 233 is isolated from the support structure 241 of the main body
207 and the robot 205 (and is "floating" relative to the main
body 207 and the robot 205). Further in accordance with the
above embodiment of the invention, a conventional bellows seal
(not shown) may be employed between the domed bottom 233 and
25 the robot 205 to allow the domed bottom 233 to move vertically
relative the robot 205 without breaking a vacuum seal formed
therebetween (e.g., via the o-rings 245, 249 in FIG. 3). In
this manner, the domed bottom 233 is free to deflect during
evacuation and venting of the transfer chamber 203, and fewer
30 design constraints (e.g., in terms of material thickness,
strength, etc.) are placed on the design of the domed bottom
233. Further, deflections of the domed bottom 233 will not
affect the position and/or calibration of the robot 205.

FIG. 5 is a schematic vertical cross-sectional view
of a processing tool 501 provided in accordance with an
alternative embodiment of the invention. The alternative
inventive processing tool 501 may be the same in all respects
5   as the inventive processing tool 201 shown in FIG. 2 except
that the processing tool 501 of FIG. 4 may have a transfer
chamber 503 which has a lid 527 provided in a domed
configuration (instead of employing the flat transfer chamber
lid 227 shown in FIGS. 2 and 3). A transfer chamber lid having
10   a domed configuration is disclosed in the above-referenced
patent application serial no. 09/523,366 (Attorney Docket No.
2801).

The foregoing description discloses only exemplary
embodiments of the invention; modifications of the above
15   disclosed apparatus which fall within the scope of the
invention will be readily apparent to those of ordinary skill
in the art. For example, although the inventive domed transfer
chamber bottom has been illustrated above as having a concave
configuration, the domed transfer chamber bottom may
20   alternatively have a convex configuration (i.e., such that a
vertical distance between a central portion of the domed bottom
and the lid of the transfer chamber is less than a vertical
distance between an outer edge of the domed bottom and the lid
of the transfer chamber). As used herein, a "domed" bottom or
25   lid need only have a portion thereof, such as an outer portion,
domed or curved. The remainder of the bottom or lid may assume
other shapes and/or may be flat. Such a domed bottom (or lid)
design may be based on one or more of transfer chamber height
or width, the height or width available underneath a transfer
30   chamber, or the like.

It should further be recognized that if a domed lid
is employed, as shown in the embodiment of FIG. 5, the
configuration of the lid may be convex (as also disclosed in

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the above-referenced U.S. patent application Serial No.
09/523,366) rather than the concave lid configuration shown in
FIG. 5.

      Although the present invention is particularly

5   advantageous when applied to a large transfer chamber of the
type used in processing glass plates, the invention is also
applicable to other types of processing tools, including those
used to process silicon wafers. The invention is applicable to
transfer chambers adapted to couple to any number of processing

10   chambers and to any number of load lock chambers.

      It should be understood that at least some of the
transfer chamber components illustrated in FIG. 3 can be
combined with other components. For example, the lid 227 and
the top member 223 can be combined to form a single piece that

15   sealingly closes the top of the main body 207 of the transfer
chamber 203. Accordingly, as used in the appended claims, the
term "lid" should be understood to include one, two or more
pieces which seal the top of a transfer chamber. It is also
contemplated that components of the inventive transfer chamber

20   shown as a single piece in FIG. 3 may be constituted by two or
more pieces.

      As another alternative, the bottom member 233 and the
plug member 243 could be combined to form a single integral
piece that seals around a substrate handling robot.

25   The inventive transfer chamber may be arranged to
accommodate any type of substrate handling robot, including a
"frog leg" style robot.

      If the bottom of the transfer chamber is employed to
support the weight of the main body of the transfer chamber

30   and/or a portion of the weight of each load lock and process
chamber coupled to the transfer chamber (e.g., if the domed
bottom is not floating relative to the main body), the design
of the domed bottom may be affected (e.g., the height of the

non-domed portion of the bottom, the radii of the domed portion
of the bottom, material thickness, etc.).

      Accordingly, while the present invention has been
disclosed in connection with exemplary embodiments thereof, it
5   should be understood that other embodiments may fall within the
spirit and scope of the invention, as defined by the following
claims.